Appendix E: Safety Analysis

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Safety is a major concern of both existing and potential bicyclists. For those who ride, safety is typically an ongoing concern. For those who do not ride, it is one of the most cited reasons for avoiding cycling. A 2004 survey conducted by the National Highway Traffic Safety Administration (NHTSA) documents national bicycle and pedestrian injury and crash trends. The numbers show that, nationwide, the total number of reported cyclist fatalities has dropped dramatically since 1994, with 802 fatalities reported in 1994 and 725 fatalities reported in 2004. In comparison, total traffic fatalities have increased by 5% over this ten-year period.[3] It should be noted that bicycle crashes are generally underreported as many crashes result in any minor injuries, do not involve other vehicles, are not self-reported and do not involve the police. Crash data does not take into consideration "near misses," which characterize conditions at many high-risk locations without reported incidents.

The same NHTSA study shows that in 2004, of all Wisconsin traffic fatalities 1.8% were cyclist fatalities. This is slightly lower than the nationwide average of 2.0%.[4]

A Summary of Frequencies and Common Crash Types

Although more than half of cyclist fatalities in the U.S. are adults (age 25 and older), children under the age of 16 are more likely to be killed or injured while riding a bicycle. In 2004, adult cyclists (25 and older) accounted for more than half of the cyclist fatalities in the U.S., and cyclists under the age of 16 accounted for 21% of the fatalities and 32% of the injuries. However, cyclists under the age of 16 have higher fatality and injury rates than other age groups (2.5 fatalities per million population, about 24% higher than the overall cyclist fatality rate, and 286 injuries per million population, more than twice the injury rate for cyclists of all ages).

According to a 1990 study of 3,000 bicycle crashes in six states, the most common type of bicycle-vehicle crash involved a motorist failing to yield right-of-way at a junction (21.7% of all crashes).[5] More than one-third of these types of crashes involved a motorist violating the sign or signal and driving into the crosswalk or intersection and striking the bicyclist. The next most common types of vehicle-bicycle crash involved a bicyclist failing to yield right-of-way at an intersection (16.8%), a motorist turning or merging into the path of a cyclist (12.1%), and where a bicyclist failing to yield right-of-way at a midblock location.

Sidewalk Riding

Though riding on the sidewalk may feel safer than riding with motor vehicle traffic in the street, it is often more dangerous and is illegal in many locations. Wisconsin State Statute 346.94(1) prohibits sidewalk bicycle riding, unless specifically permitted through local ordinances. In the city of Milwaukee, it is illegal to ride on public sidewalks, however, this ordinance does make an exception for on-duty police officers and children under the age of 10.[6] Reasons why sidewalk riding is less safe than street riding include:

- Cyclists riding on sidewalks can be obstructed from view by cars parked along the street and landscaping.
- Motorists and pedestrians do not expect to encounter cyclists on sidewalks. The unexpected appearance of a cyclist can surprise all of the involved parties and result in reduced reaction times and increased likelihood of a crashes.
- Cyclists riding on the sidewalk encounter more potential conflict points. Generally, these conflict points are driveways and intersections, but they can also include areas where street furniture creates pinch points, and areas where people congregate (e.g., bus stops).

Participants in a bike education course gearing up for a ride in the rain

3 Traffic Safety Facts, 2004 Data. "Pedalcyclists" NHTSA, DOT # HS 809 912

4 Ibid.

5 Pedestrian and Bicycle Crash Types of the Early 1990's, Publication No. FHWA-RD-95-163, W.H. Hunter, J.C. Stutts, W.E. Pein, and C.L. Cox, Federal Highway Administration, Washington, DC, June, 1996.

6 Additional details can be found at http://www.city.milwaukee.gov/ImageLibrary/User/milbtf/ch102.pdf.

- Cyclists riding on the sidewalk often travel 2 to 3 times faster than pedestrians (8 to 10 MPH versus 2-3 MPH) which can be difficult for sidewalk and roadway users to see and respond to.

If cyclists choose to ride on the sidewalk, they should ride slowly and with the flow of traffic, and should be aware of motorists entering and exiting driveways and side streets. Children should be closely supervised by adults and encouraged to ride in the street as they get older and their riding skills improve.

Wrong-way riding is a widespread, yet unsafe, cyclist behavior. Though wrong-way riding accounts for only 2.5% of all bicycle crashes, it has been shown to be a contributing factor in several other types of crashes.[7] According to a 1996 FHWA study, wrong-way bicycling is involved in:

- 24% of crashes where motorists drive through an intersection
- 67% of crashes where motorists drive out of an alley or driveway
- 57% of crashes where motorists drove out of a stop sign
- 23% of crashes where a bicyclist rode out of a stop sign
- 44% of crashes where a bicyclist rode out with no stop sign
- 78% of all crashes where a motorist turned left in front of a cyclist

Data Collection for Milwaukee, Wisconsin

Bicycle-related crash data was collected for six years in Milwaukee, from 2002 through 2007. This data was provided by the Traffic Operations and Safety Laboratory at the University of Wisconsin-Madison as a service to the Wisconsin Department of Transportation Bureau of Highway Operations. A crash is defined as "reportable" if the incident results in injury or death, or if property damage exceeds $1,000 for any single person involved and occurs between a cyclist and a motor vehicle. Crashes that occurred on private property or in parking lots were not included in this analysis. Information on fault and contributing crash factors were not considered in this analysis due to a lack of available data.

Crash Analysis

Table 9 shows the distribution of crashes by year. From 2002 through 2006 the annual number of crashes shows a steady decline from 204 in 2002, to 136 in 2006. In 2007 the data show an increase of 20 crashes over the prior year. It appears that the number of crashes is decreasing annually. A spike in a single year is not sufficient evidence to indicate sustained increases or decreases in the number of bicycle related crashes.

The six-year time span shows an average of 163 crashes occurring each year.

Table 9: Bicycle Related Crashes in Milwaukee

Year	Total Crashes	% of Bicycle Crashes
2002	217	21%
2003	169	17%
2004	162	17%
2005	154	16%
2006	136	14%
2007	156	16%
Total: 981 crashes		

The average annual bicycle crash rate for the city is 0.25 per thousand residents. As shown in Table 9, there were 981 bicycle-related crashes reported in Milwaukee from 2002 to 2007, with 69 collisions resulting in property damage only, 906 resulting in injuries, and six resulting in fatalities. From 2002 to 2007 Milwaukee averaged

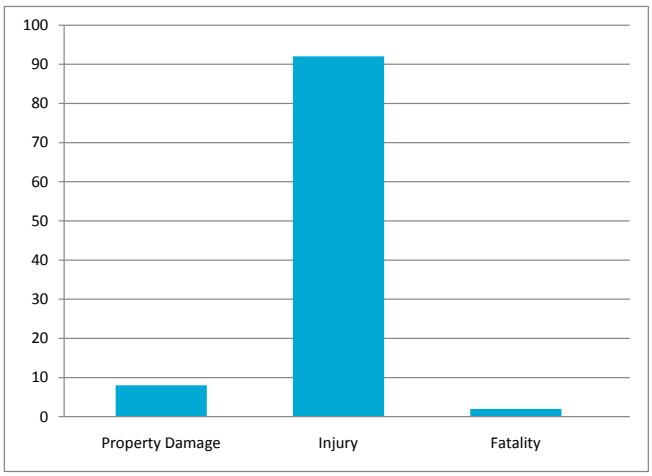


Figure 1: Crash Severity

7 Pedestrian and Bicycle Crash Types of the Early 1990's, Publication No. FHWA-RD-95-163, W.H. Hunter, J.C. Stutts, W.E. Pein, and C.L. Cox, Federal Highway Administration, Washington, DC, June, 1996.

152 injury collisions per year. Additionally, compared with statewide bicycle fatality rates (2.5 fatalities per 1 million population), Milwaukee falls slightly below the expected range with six reported cyclist fatalities between 2002 and 2007.[3]

Age and Gender

The majority of cyclists that were involved in crashes in Milwaukee were children under the age of 15. This is consistent with trends noted by the FHWA that a greater percentage of crashes involve individuals under 16 years of age. The Milwaukee data show that older cyclists are less likely to be involved in crashes. The majority of cyclists involved in crashes were male. This likely reflects the typically higher cycling rate among males.

Table 10: Cyclist Crashes by Age and Gender

Age Group		Female	Male	Total
7-14	Total Number	119	265	384
	% of Sample	12.8%	28.5%	41.3%
15-24	Total Number	66	191	257
	% of Sample	7.1%	20.6%	27.3%
25-34	Total Number	26	66	92
	% of Sample	2.8%	7.1%	9.9%
35-44	Total Number	16	64	80
	% of Sample	1.7%	6.9%	8.6%
44-55	Total Number	16	56	72
	% of Sample	1.7%	6.0%	7.8%
55 +	Total Number	6	38	44
	% of Sample	0.6%	4.1%	4.7%
Total	Total Number	249	680	929
	% of Sample	26.8%	73.2%	100.0%

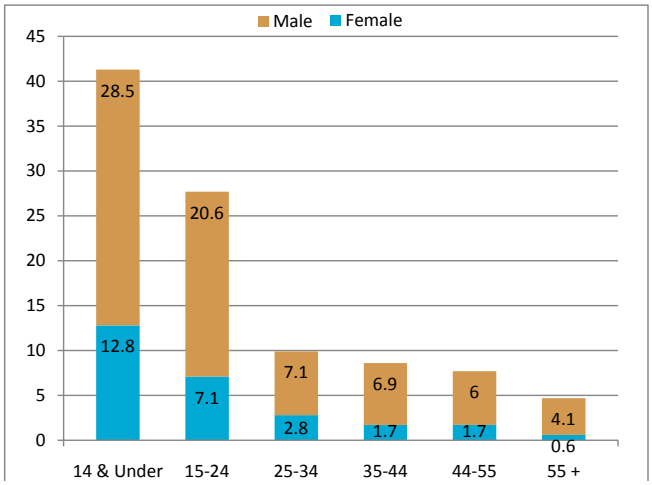


Figure 2: Total Percent of Cyclist Crashes by Age and Gender

Crash Location

All crashes in this analysis occurred within an urban setting. Of the 981 recorded crash locations, 646 (66%) occurred in intersections. About 35% (335 crashes) occurred mid-block.

Alcohol Involvement

Alcohol involvement was noted in 27 (2.8%) of all reported instances. This is lower than rates reported by the FHWA, which reported about 5% of all crashes.[8] Alcohol was involved in 2 of the 6 reported crash fatalities in Milwaukee. These numbers are consistent with fatality rates reported by the NHSTA.[9]

Crash Month

Table 11: Month of Crash Event

Month	Total Crashes	% Crashes
January	16	1.6%
February	12	1.2%
March	18	1.8%
April	59	6.0%
May	91	9.3%
June	141	14.4%
July	197	20.1%
August	200	20.4%
September	123	12.5%
October	79	8.1%
November	33	3.2%
December	12	1.2%
	981	100.0%

The pattern of crashes follows seasonal weather fluctuations, with greater numbers of crashes occurring April through September and peaking in July and August. It is possible that some crashes are attributed at least in part to winter conditions, but greater influence is exerted by the greater numbers of people cycling during warmer months.

8 Pedestrian and bicycle Crash Types of the Early 1990's FHWA-RD-95-163

9 Injury rates from Traffic Safety Facts, 2004 Data. "Pedalcyclists" NHTSA, DOT # HS 809 912

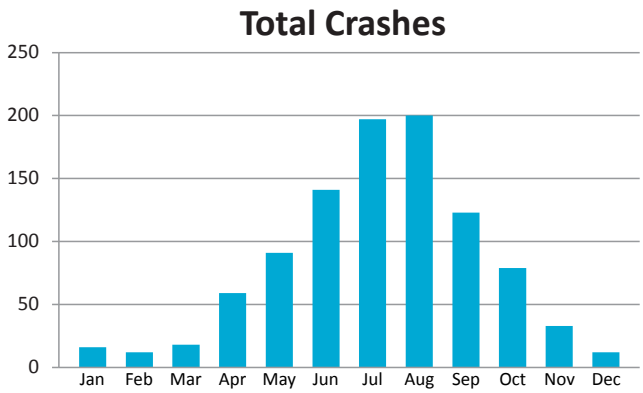


Figure 3: Month of Crash Event

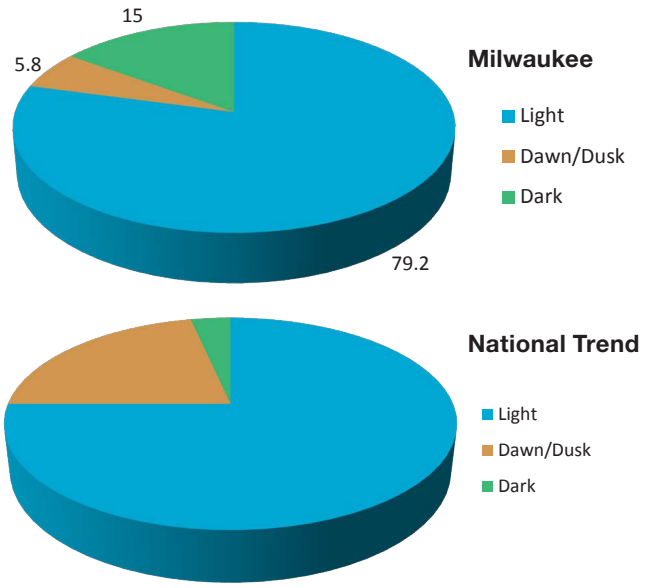
Time of Day

Table 12: Time of Day

Light Condition	Total Crashes	% Crashes
Dark	8	3.4
Dawn	6	2.5
Dusk	45	19.1
Light	177	75.0
	236	100.0%

Table 12 shows lighting conditions, which were only reported for 236 of 981 crashes. This data is fairly consistent with patterns reported in other areas, though crashes occurred with less frequency during daylight or in dark conditions and more frequently at dawn and dusk. Figure 4 compares lighting conditions in Milwaukee to reported national trends. It appears that a disproportionate number of reported crashes (19.1%) occurred during dusk. Generally, lighting conditions at dusk and dawn are recognized as the most difficult times to see cyclists and represent higher numbers of injury and fatality related crashes. More instances occur during dusk due to the numbers of drivers and cyclists commuting during this time. These results may not represent a clear picture of the effect lighting plays in crashes within Milwaukee due to a lack of reported information.

Figure 4: Crashes by Time of Day and National Trend[s1]



1 Pedestrian and bicycle Crash Types of the Early 1990's FHWA-RD-95-163

Day of Week

Crashes occurred on every day of the week, with a slightly higher percentage of crashes occurring on Tuesday and Friday. As this data does not take into account the difference in numbers of people biking each day, it is not possible to determine if the rate of crashes differs between weekdays and weekends. This data is consistent with trends observed in other areas.[10]

Table 13: Day of Week

Day of Week	Total Crashes	% Crashes
Sunday	135	14.7
Monday	131	14.2
Tuesday	153	16.6
Wednesday	143	15.5
Thursday	123	13.4
Friday	158	17.2
Saturday	138	15.0
	981	100.0%

10 Pedestrian and bicycle Crash Types of the Early 1990's FHWA-RD-95-163

Action at Time of Crash

Table 14: Cyclist Action at Time of Crash

Cyclist Action*	Total Crashes	% Total
Going Straight	807	82.9
Other	64	6.6
Left Turn	46	4.7
Right turn	16	1.6
Action not Noted	14	1.4
Stopped	5	0.5
U-Turn	5	0.5
Slowing or stopped	3	0.3
Merging	3	0.3
Changing Lane	2	0.1
Legally Parked	1	0.1
Stopped	1	0.1
U-Turn	1	0.1
Grand Total	968*	100
*Not all crashes list a cyclist as driver involved in the crash		

Table 14 shows cyclist action at the time of the crash event. In the majority of crashes, the cyclist was going straight. The second most common action at the time of a crash was making a left-hand turn. The right-hand turn is the third most common cyclist action. Milwaukee crashes related to cyclists making left hand turns is close to the national average of 4.3% of all bicycle crashes, according to research performed by the Highway Safety Center at the University of North Carolina and published by the FHWA.[11]

Table 15 shows the non-cyclist action at the time of the crash. This analysis includes all vehicles except bicycles. The most common non-cyclist actions at the time of the crash were traveling in a straight line (55.9%), making a right-hand turn (22.8%), or making a left-hand turn (11.4%). This data suggests that the number of crashes occurring in conjunction with left- and right-hand turns in Milwaukee is significantly higher than it was in studies performed by the FHWA where motorists were typically turning left in only about 6% of crashes and turning right in about 5% of all crashes.

Table 15: Non-Cyclist Action at Time of Crash

Non-bicycle driver action at time of crash	Total Crashes	% Crashes
Going straight	151	55.9
Right turn	210	22.8
Left turn	105	11.4
Slowing or stopped	43	4.7
Backing	11	1.2
Other	10	1.1
U-Turn	6	0.7
Legally parked	4	0.4
Merging	4	0.4
Changing lane	3	0.3
Parking	3	0.3
Right-turn on red	3	0.3
Over taking right turn	2	0.2
Illegally parked	1	0.1
Over taking left turn	1	0.1
Total*	922	100
*Excludes records where vehicle type was not noted		

11 FHWA Course on Bicycle and Pedestrian Transportation, Chapter 4.

Crash Corridors

Top Eleven Crash Corridors

Crashes were concentrated along eleven corridors during the study timeframe. These eleven locations represent 2.4% of all corridors with reported crashes, but account for 135 individual incidents, or 15.6% of all crashes reported on roadways. These corridors should be analyzed in greater detail to understand the specific crash causes and contributing factors. Care should be taken when interpreting this data. A street with a high number of crashes and a significant amount of bicycle traffic is likely less dangerous than a street that has the same number of crashes and less bicycle traffic. If possible, the amount of bicycle traffic along each of these streets should be validated with counts, or the expert knowledge of frequent cyclists who can help gauge the relative level of bicycle traffic. Streets with higher crash rates and less bicycle traffic may represent a greater safety risk. The City of Milwaukee should consider these key corridors as potential targets for future physical improvements aimed at reducing crashes and increasing cyclist safety and comfort.

Table 16: Top 11 Crash Corridors

Top Crash Corridors	Total Crashes
W National Avenue	16
N 27 ST	15
N 35 ST	15
W Capitol Drive	14
W Center St	13
S 20 ST	11
W North Ave	11
N Oakland Ave	10
N Teutonia Ave	10
N Water St	10
S Howell Ave	10

Corridors with Five or More Crash Locations

Over the six-year period, crashes were reported in 467 locations. Of these corridors, 47 (10%) had been the site of five or more incidents, for a total of 367 (36%) crashes over six years. These corridors may carry more bicycle and motor vehicle trips or possess more areas where roadway configurations create bicycle/vehicle conflicts. These corridors should be considered for more detailed analysis of physical conditions or targeted education campaigns.

Table 17: Frequent Crash Corridors

Corridor Name	No. Crashes	Corridor Name	No. Crashes
W National Ave	16	W Oklahoma Ave	7
N 27 St	15	N 60 St	6
N 35 St	15	N 76 St	6
W Capitol Dr	14	N 8 St	6
W Center St	13	S Kinnickinnic Ave	6
S 20 St	11	W Fond Du Lac Ave	6
W North Ave	11	W Greenfield Ave	6
N Oakland Ave	10	W Lincoln Ave	6
N Teutonia Ave	10	W Morgan Ave	6
N Water St	10	E Brady St	5
S Howell Ave	10	E Locust	5
E Locust St	9	N 38 St	5
N 6 St	9	N Green Bay Ave	5
S 27 St	9	S 13 St	5
S 6 St	9	S 16 St	5
W Vliet St	9	S 84 St	5
N 20 St	8	W Appleton Ave	5
N 7 St	8	W Bluemound Rd	5
S Layton Blvd	8	W Burleigh St	5
W Hadley St	8	W Hampton Ave	5
W Locust St	8	W Mitchell St	5
W Wright St	8	W State St	5
N Sherman Blvd	7	W Wisconsin Ave	5
S 35 St	7		

Crash Reduction: Education, Enforcement, and Outreach Efforts

The city of Milwaukee has identified bicycle crash reduction as a priority of the Bicycle Master Plan Update. Education and outreach programs are designed to increase bicyclists' safety by raising awareness of bicycling, connecting current and future cyclists to existing resources, educating them about their rights and responsibilities, and encouraging residents to bicycle more often (thus reducing crash risk via the well-researched "Safety in Numbers" principle). Successful measures to reduce crashes will lessen the perception that bicycling is a dangerous activity, thereby increasing the number of bicyclists on Milwaukee's roadways. Key target audiences of these programs include drivers, law enforcement personnel, current and potential (interested) cyclists, students, children and families, and school personnel.

Analysis of existing crash data for the city of Milwaukee demonstrates that the following deficiencies exist in the area of crash reduction:

Table 18: Education, Enforcement, and Outreach Conclusions and Recommendations

Trend	Recommendation
Children are over-represented in bicycle-vehicle crashes	Safe Routes to School programs that teach bicycle safety skills will reduce youth crash risk
66 percent of crashes occurred at intersections	Motorists and bicyclists need more information about intersection safety and cyclist rights and responsibilities. Possible approaches include enforcement actions and diversion classes, creating channels to get bicycling information to cyclists, and media campaigns.
Dusk was a time when bicyclists were more likely to be involved in a crash	Bicyclist lighting programs are needed
More crashes occur in the summer months	Less-experienced cyclists may be on the road during warmer weather; they would benefit from safety training Motorists may not have the information they need to avoid crashes with cyclists Possible approaches include enforcement actions and diversion classes, creating channels to get bicycling information to cyclists, and media campaigns.
While bicyclist and motorist crash behavior is not complete enough to provide a full analysis of common crash types, Milwaukie crash data and national trends seem to indicate that common crash types include crashes where the bicyclist is proceeding straight and the motorist turns (right or left) across the path. Another common crash pattern is motorists proceeding straight at point of crash, which may indicate a failure to yield error (on the part of the motorist or bicyclist).	Motorists and bicyclists need more information about intersection safety and cyclist rights and responsibilities. Possible approaches include enforcement actions and diversion classes, creating channels to get bicycling information to cyclists, and media campaigns.
The number of crashes is decreasing annually even as ridership increases. (Note: this finding is consistent with national research that indicates that crash rate decreases as more people ride bicycles.)	Milwaukie residents may not be aware that safety is improving. Promoting bicycling as a safe and accessible activity will encourage more people to bicycle, thus increasing safety on the road through the "safety in numbers" principle.
Insufficient crash data made it difficult to complete a thorough crash analysis.	It is recommended that crash reporting and data tracking be improved.

In addition, general crash reduction principles based on national best practices include:

- Route planning and wayfinding assistance as a way to direct cyclists to facilities that have been specifically enhanced to increase safety
- Helmet promotion
- Enforcement best practices
- Cycling promotion as a way to increase awareness and road safety
- Websites as an effective way to share cycling information with the public

In addition, there are numerous existing efforts that can be enhanced to increase crash reduction messaging, such as Safe Routes to School, Bike to Work Week and the Bike Licensing program. Program details can be found in Appendix L.